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SBF: multi-wavelength data and models

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Abstract. Recent applications have proved that the Surface Brightness Fluctuations (SBF) technique is a reliable distance indicator in a wide range of distances, and a promising tool to analyze the physical and chemical properties of unresolved stellar systems, in terms of their metallicity and age. We present the preliminary results of a project aimed at studying the evolutionary properties and distance of the stellar populations in external galaxies based on the SBF method.

On the observational side, we have succeeded in detecting I-band SBF gradients in six bright ellipticals imaged with the ACS, for these same objects we are now presenting also B-band SBF data. These B-band data are the first fluctuations magnitude measurements for galaxies beyond 10 Mpc.

To analyze the properties of stellar populations from the data, accurate SBF models are essential. As a part of this project, we have evaluated SBF magnitudes from Simple Stellar Population (SSP) models specifically optimized for the purpose. A wide range of chemical compositions and ages, as well as different choices of the photometric system have been investigated. All models are available at the Teramo-Stellar Populations Tools web site: www.oa-teramo.inaf.it/SPoT.

We have measured B- and I-band SBF magnitudes for 6 elliptical galaxies observed with the ACS camera on board of HST: NGC 1407, NGC 3258, NGC 3268, NGC 4696, NGC 5322 and NGC 5557. Concerning I-band images, their high S/N ratio allowed us to obtain SBF measurements in different regions of the galaxies – 5 concentric annuli (Cantiello et al. 2005). On the contrary, the B-band images have low S/N (~ 1), and SBF amplitudes can be measured only in one single annulus. The reliability of these B-band measurements has been verified via numerical simulations, by using a procedure which is able to reproduce realistic images of elliptical galaxies, including the stellar SBF signal.

The general lack of B-band SBF data hampered up to now a detailed comparison with models, our observational data represent the first sample of B- and I-band SBF measurements for a fair sample of distant galaxies. Figure 1 (left panels) shows the comparison of absolute SBF magnitudes versus $(B-I)_0$ color data with SSP models from the Teramo Stellar Populations Tools group (SPoT models, Raimondo et al. 2005). SBF and color data appear generally well reproduced by means of standard SSP models in the \bar{M}_I vs. $(B-I)_0$ panel. However, there is a considerable mismatch between SBF models and data for

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some objects in the \bar{M}_B vs. $(B-I)_0$ panel. Such disagreement does not depend on the distance modulus adopted to estimate the absolute SBF magnitudes, in fact the same mismatch is present also in the distance-free SBF-color vs. color $(B-I)_0$ (Cantiello et al. 2006, ApJ submitted). In addition, adopting other standard SSP models from literature (e.g. Blakeslee et al. 2001) or also non-standard SSP models (e.g. alpha enhanced models) the disagreement is not removed.

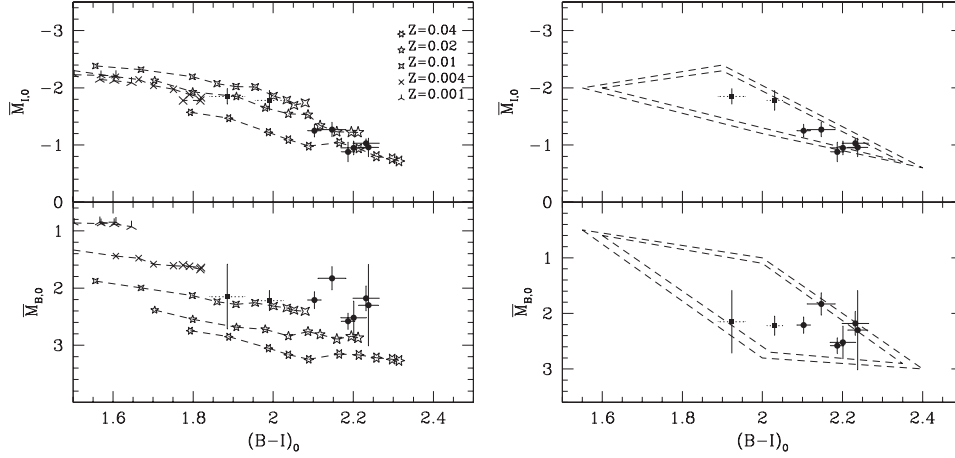


Figure 1. Left panels: SBF absolute magnitudes vs. the $(B-I)_0$ color derived from HST data (full dots). Full squares mark the only two other galaxies with literature data. SSP models are from the SPoT group for the labeled chemical compositions and $2 \text{ Gyr} \leq t \leq 14 \text{ Gyr}$ (symbols of increasing size mark older ages). Right panels: same data as left panels but compared to CSP models.

One possible solution seems to be the use of Composite Stellar Populations (CSP). In Figure 1 (right panels) we compare the Blakeslee et al. (2001) CSP models with the present data. These CSP models are obtained combining SSP models in such a way to mimic, at least approximately, the evolution of an elliptical galaxy. With these models the disagreement between SBF data & models disappears, as it is completely accounted for by CSP with a fraction of old and metal-poor ($t \sim 14 \text{ Gyr}$, $[\text{Fe}/\text{H}] \sim -1.3$) stars as high as 8%, combined with a dominant contribution from an old and metal rich stellar component.

In conclusion, our data seem to show that while the integrated properties of some galaxies might be well interpreted within the scenario of classical SSP models, there are few objects whose observational properties can only be interpreted by means of more complex stellar populations systems. In this view, SBF and SBF colors, coupled with classical photometric data appear to be a very interesting tool to understand the properties of the unresolved stellar systems in distant galaxies.

References

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